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# THE JOURNAL OF ENGINEERING EDUCATION

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## THE FORMATION OF SECTIONS.

BY R. S. KING,

Georgia School of Technology, Vice-President of the Society.

The formation of sections of the Society for the Promotion of Engineering Education has many benefits to confer upon those who make up the sections. One of the chief arguments advanced against their formation is that they are nothing more than another form of faculty meeting—for which most engineering instructors seem to have little esteem. Another argument advanced is that most men are already engaged in active work with "this or that" engineering society. Investigation of the latter argument seems to indicate that a very small percentage of the engineering faculty take active part in local engineering sections. If a section of the Society is formed does it need to be an adjourned faculty meeting? Can meetings be made worth while to engineering instructors? That such meetings can be made worth while has been demonstrated by some sections.

Just what benefit can be derived? First, contact with your fellow teacher. There is always the social side to be considered in which some provision must be at hand for the promotion of acquaintance among men of the faculty. How many times do you get the following reply to your question concerning some other instructor, "I don't know him, he is in another department"? Should this be?

Second, the beginner in teaching work is entitled to receive help and guidance, if we are to believe the threadbare remark that men of broad caliber never go into the teaching profession. It is just as easy to develop broad men in the teaching profession as it is to develop them in the industries. This, of course, must be done by the "higher ups." The presentation of papers and their discussion leads to a broader understanding

of many questions involved in the real promotion of engineering education by all concerned.

Third, the discussion of papers and other topics of interest allows for a development of the individual and gives him an opportunity for self expression. Just at this time when all of the engineering courses are under investigation, the opportunities for profitable discussion are unlimited.

The formation of S. P. E. E. sections should not be limited just to members in the society but extended to all interested. If meetings are limited in time and held during day periods it might add to their attractiveness, especially if some live leader is placed in charge of each meeting and topics chosen which do not "smack" of faculty meeting discussions.

## PROGRESS IN THE SOCIETY'S INVESTIGATION OF ENGINEERING EDUCATON.

H. P. Hammond, Associate Director of Investigations.

By the end of October (1924) the "organization stage" of the investigation of engineering education had been practically completed. It is too early at this time to give a detailed report of the progress of the work, though judging by the rate at which results of the studies are being received at the Headquarters Office, very satisfactory progress is being made. The present news item will therefore merely deal with the organization which has been effected.

As has been stated in previous announcements, the first stage of the work is being directed to gathering facts with the purpose of furnishing a basis not only of determining the present state of engineering education but of indicating its fundamental purposes and the steps which should be taken more effectively to carry out those purposes. The agencies which have been established for gathering the facts (and for carrying on later stages of the work) consist at present of four committees of the Society and committees in each of a large number of cooperating colleges. To each of the four committees of the Society has been assigned one of the four fields of study with which the investigation is now dealing. These fields of study and the personnel of the committees dealing with them follow.

*Committee on Studies Relating to Engineering Students and Graduates.*

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E. B. Roberts, Secretary, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Penn.

J. W. Hallock, University of Pittsburgh, Pittsburgh, Penn.

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*Committee on Studies Relating to Teaching Personnel.*

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H. E. T. Haultain, University of Toronto, Toronto, Canada.
P. F. Walker, University of Kansas, Lawrence, Kansas.

*Committee on Studies Relating to the Services Rendered by and the Facilities of the Colleges of Engineering.*

Harold Pender, Chairman, University of Pennsylvania, Philadelphia, Penn.
E. H. Rockwell, Rutgers University, New Brunswick, N. J.
C. R. Richards, Lehigh University, Bethlehem, Penn.
Anson Marston, Iowa State College, Ames, Iowa.
C. M. Allen, Worcester Polytechnic Institute, Worcester, Mass.

H. S. Evans, University of Colorado, Boulder, Colo.
George E. Russell, Massachusetts Institute of Technology, Cambridge, Mass.

The foregoing committees are acting in advisory and supervisory capacity with the Director's Office. While it was the desire to obtain their assistance in preparing the various projects of the study, it was deemed necessary to start work by the college committees on at least some of the projects early this fall. At the same time it was not possible to appoint the committees of the Society and start their work until the opening of college this academic year. Accordingly studies relating to engineering students and graduates and to the problems of admissions and eliminations—these appearing to constitute the more laborious of the projects contemplated—were prepared during the past summer in the Headquarters Office and have now been forwarded to a number of faculty committees with invitations to undertake all or part of them. Response to this invitation has been excellent. The work is now in progress in a considerable number of institutions and is well advanced in some of them. Not all of the committees to which studies were forwarded have notified the Headquarters Office just which portions of the work they will undertake. It is hoped that they will do so at an early date so that the office records of the progress of the work can be kept accurate and up-to-date at all times.

The widespread interest in the investigation and the promptness of the response to the formal invitation to coöperate in the work is shown by the fact that approximately ninety colleges have signified a desire to coöperate. These colleges are located all the way from Fredericton, New Brunswick, to Honolulu; and from Saskatchewan to Florida. The following is a list of institutions which have either appointed committees, or, in a very few instances, have designated other agencies of coöperation. The list is published not only to indicate the interest in the undertaking but also to invite correction of any errors or omissions. If any are noted it is requested that the Office of the Director of Investigation

(Room 1607, 33 West 39th Street, New York City) be notified so that correction may be made.

### Coöperating Institutions and Names of Chairmen of Committees or individuals Designated to Receive Communications.

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Worchester, Massachusetts
Yale Univervsity.....Prof. B. B. Gottsberger
New Haven, Connecticut

THE JOURNAL OF ENGINEERING EDUCATION will contain news items from time to time relative to the progress of the investigation. It is requested that the committees in the colleges keep the Headquarters Office informed of developments in their work so that they may be included in future reports.

# WHAT MAKES A COURSE A CURSE?*

BY J. CROSBY CHAPMAN,
Yale University.

In the catalogue of a western institution, at the close of a statement of an elaborate and imposing syllabus of studies, the following remark was found: "It takes four years to complete this curse." No doubt the printer was technically in error, but he may have set better than he knew.

The problem I should like to discuss may follow from this remark. In its most provocative form it may be worded: "What makes a course a curse?" and the thesis that I shall maintain is that any course is cursed to the extent to which it is not the best our present facilities and state of knowledge permit. This will demand that we examine some of the shortcomings of general professional education. It is unnecessary for me to point out that I am not an engineer and that what I say will be focused rather on professional education in general than upon specific knowledge within the field of engineering education. I shall however assume that my auditors will judge the extent to which the cap fits and make the necessary application to the particular fields in which they are interested.

In the first place, I should like to call attention to the fact that in many cases professional education is but ill-adapted to the later needs of the student. To remedy this basic evil occupational analysis has been attempted. If the courses of our institution are to articulate with the later professional life no one would question that detailed occupational analysis has a great contribution to make, but it is only too apparent that this particular method of investigation is fraught with great dangers, and does not give the simple answer to the question of curriculum content which many suppose.

* An address given before the New England Section of the S. P. E. E. New Haven meeting, April 5, 1924.

From the standpoint of the occupational activities of those within the profession, we may note that within the training institution or within the professional school we are preparing individuals for two distinct types of work. On the one hand there is the type of training which will work for the advancement of the profession and the increase in the theoretical knowledge necessary for its growth. On the other hand, there is also the training which will enable the student to join the larger group within any occupation, who are not so much interested in advancing the status of the profession as in "carrying on" the more or less routine work which the profession demands.

Now as soon as we analyze an occupation we discover that the large majority of the activities fall in the "carrying on" class. Similarly the majority of the individuals are engaged in the routine or standardized tasks. In spite of this fact the schools of engineering in their curriculum have always prided themselves upon the fact that their training is couched in terms that work for the advancement of the profession. On this account we find given to most, if not to all, of the students a large number of theoretical courses. While this is extremely good for the picked student who is going to give his attention to the investigatory aspect of the subject, the large number of theoretical courses overload and confuse the majority of the students. There is need for every professional school to ask itself whether, in view of the great differences within the occupation itself, there is not more need for analysis of its student body into (1) the scientific group; (2) the "carrying on" group.

Under the same heading another point needs mention, and here possibly I speak especially of engineering. It is a well-known fact that some years after the student leaves the training institution he discovers that his success in the job is less dependent on the technical apects of engineering than it is on a sound knowledge of such subjects as economics, sociology, psychology. In many cases the engineering schools,

like other professional schools, have been very slow to adapt their curricula to the changing needs of their clientele.

Having shown the need for the curriculum to reflect much more fully the differentiated needs of the student body, we may now pass on to another short-coming of professional education. In many cases, the course of study has long since ceased to be adapted to the learning capacity of the student. One might call attention to what has happened in the professional course of study as a result of the increase in the body of knowledge. Each framer of the course, or textbook writer, before he proceeds to lay down the task for his own student body or for his own textbook, takes all the other courses or all the previous textbooks that have been written and includes all this traditional material. Then to an already overburdened course of study he makes his own individual contribution. The result is that in many branches the courses of study and the textbooks are enormously overloaded. It cannot be too clearly realized that the difficulty of a study is, in the mathematical sense, a function of the speed of presentation. Many a course which contains no so called difficult material is presented at such a speed, because a certain traditional ground has to be covered, that it becomes impossible for the ordinary student to master the elements. Good teaching demands considerable preparation of the student for the new material. It demands deliberate presentation; it demands association with old ideas; and above all it demands application to other problems than those in which the particular body of information arose. As the scope of knowledge increases, the speed of instruction is accelerated; with the result that the student is hastily conducted through territory which he is totally unable to appreciate. The outcome is only too obvious. The learner has a superficial acquaintance with a vast amount of material, but, because he has not had the time to apply it to other problems, he feels no confidence in its use. Our instructional efforts find their resultant in skills, knowledges and attitudes. The pertinent factor is not the question, has the instructor done his best? It is not the

question, has the student done his best? Rather, the matter of moment is: Has the student confidence in the skills? Has his knowledge wide applicability? Are his attitudes large in their incidence?

Our courses of study tell us what we are attempting, but we have most inadequate knowledge of what they are achieving. Did we measure with any considerable care the resultants of our instruction, there would be much greater readiness and openmindedness in modifying the curriculum. Having proved that our objectives are absurd, because they are impossible, we should then be in a position to consider radical changes in our programme. Until there is scientific measurement, under carefully controlled conditions, of rates of learning of different individuals in different fields, we shall be in ignorance of basic facts upon which changes in the content of curricula and the speed of instruction can be based. Engineers because of their quantitative training should be particularly hospitable to this aspect of the educational problem. It is inconsistent to be so accurate in the measurement of physical facts when in the fields of human achievement we are so slipshod. Facts and more facts, and close reasoning in the light of these facts, is what professional education demands.

Meanwhile I am not at all sure that it would not be helpful to instructors within professional schools if it were made perfectly clear to them that the amount of subject matter which is to be taught should be reduced, let us say, one-half. Accompanying this reduction there must be a clear understanding that the same amount of energy is to be put into the course. The reduced curriculum will be offset by the conscious attempt, through greater degree of application and through greater practice in its use, to make the material more meaningful. Our courses of study under such conditions would look less ambitious, but I am confident that our students would leave with much more effective skills, knowledges, and attitudes. The catalogue would decline but education would prosper.

Furthermore, even in the absence of careful evidence, we

may be sure from the analogy of other investigations made outside the professional schools that the teachers must give much greater attention to the different rates of learning within the student body All our educational institutions are guilty of criminal neglect of the well-known differences which exist in the rates of human learning. If an educational institution is to be successful it must set its face in the direction of greater differentiation of the student body. Whatever it may cost, however great may be the initial friction and the initial cost, of this adaption of the course to the varying needs of the student, it is essential.

The third shortcoming to which I should like to direct your attention, and which at the present time is the most serious factor in higher education, is the complete absence of any organized attempt to train those who are about to enter upon teaching. The problem might be stated in this form. Are the various instructors in our institutions being given the best chance to secure, under economical and controlled conditions, those skills, informations, knowledges and attitudes which are essential for the teacher? Teaching is difficult. This I suppose we all recognize.. The only possible arguments that can be used to defend our present policy of inaction in the training of teachers are: (1) either the art of teaching cannot be taught, or (2) teaching is such a simple procedure that it can be acquired as a result of a short period of trial and error by any educated individual. With reference to the first point I should like to draw your attention to the analogy that exists between teaching methods and research methods. It is somewhat strange that the individual who is the most willing to bear testimony to the importance of working in an advanced laboratory to acquire research methods is very often the individual who believes that teaching methods require no study. Now method in research and method in teaching is the same in essence. Method is nothing more than the manner in which one controls the means which are available to accomplish a certain end. Sound methods of teaching can be acquired economically only under guidance, in just the same way as

research methods can be acquired economically only under the guidance of a trained investigator.

The reply to the second argument is obvious. The lecture halls of our colleges and universities bear constant and pathetic witness to the fact that the art of instruction is not so simple that any individual of ordinary intelligence can gain a high degree of his potential efficiency in a short period of unguided trial and error teaching. While unquestionably the young teacher will be helped by the measurement movement in so far as it will set up clearly defined aims and will also give him very definite knowledge as to the extent to which these aims are being attained, there is one fundamental weakness of this method. It merely tells the instructor that somewhere in the process of his instruction he was in error. It does not give him any information as to the exact point at which he failed. The total process did not accomplish its result, but the analytical knowledge with reference to the exact place in the process where error arose is not available. Under conditions as they exist to-day the ordinary instructor when he enters upon his work is usually very interested in teaching, but he soon discovers that he is much at sea both with reference to the methods of work and to the success of his efforts. In other fields he finds adequate check, but in this field, his basic occupation, the checks are absent.

In closing therefore I should like to stress the need for much greater responsibility, on the part of the educational institution, for those who are embarking upon teaching. In this connection four recommendations might be made:

1. Every individual who is beginning to teach should be given the chance to acquire a systematic knowledge of the more fundamental principles which control education and teaching. This formal instruction must have particular reference to the level of teaching in which the individual is engaging.

2. Such an individual should be given a chance to witness good instruction. This I need hardly point out is not synonymous with watching the head of the department teach!

3. The young teacher should be given a chance to be criticized by his peers and he should welcome criticism in this field, as he does in the research enterprise.

4. Each large institution should have a major position filled by an individual whose main task it is to study the educational problems of the institution. He should serve as a consultant on the large number of educational problems which are becoming increasingly technical. This individual should be available to any member of the faculty or to departments, and should work both formally and informally especially among the younger men to create an interest in educational problems. He should feel peculiar responsibility for the younger instructors who are beginning to teach. Through coöperation with heads of departments he should be enabled to guide educational experiments and to direct the attention of teachers to the investigatory aspects of the instructional problem.

# COLLEGE EDUCATON AND PROFESSIONAL TRAINING.

BY W. E. WICKENDEN,
Director of Investigation.

If the schools of engineering are to define their function more clearly there will be occasion to differentiate between that side of their work which is *professional* in its aim and spirit and that which is essentially a part of a system of general *collegiate* education.

There appears to be a rapidly growing divergence of aim and spirit between these two educational types. The more general form of higher education, hereafter called collegiate in type, seems to be evolving rapidly toward greater adaptation to the needs and capacities of the individual student. Professional training is coming to denote a type of educational discipline which embodies in a very direct way the technique, functions and special philosophy of a well-defined calling having a special status in society. Professional schools are more and more adopting selective methods of admission designed to insure properly qualified and fairly homogeneous groups of students.

In short, in collegiate education the process is becoming accommodated to the student, while in the realm of professional training the student is expected to be accommodated to the process.

We are dealing here with terms concerning which there is no general agreement, with terms which may not admit of definition by a neat verbal formula. It is better, perhaps, to seek a common basis of understanding by a process of characterization in which contrasts are employed for emphasis. The following is not presumed to be a complete nor a meticulously exact characterization and it is being offered for comment and criticism rather than as a final draft. As will be noted it deals more with methods than with aims.

*Collegiate education* appears to have the following characteristics:

1. It is definitely articulated with secondary education. Articulation implies a structural joint between two mutually adjusted members and not a mere surface of contact. As the methods and content of secondary education shift in response to public demands, collegiate education has partially accommodated itself to these changes. On the other hand secondary education has always been adjusted to collegiate education, although of late to a diminishing degree.

2. It accommodates itself as fully as good educational standards will allow to variations in individual students by providing elections in the system of studies, by testing individual abilities, by grouping students according to evidences of their ability, by honors courses or autonomous courses for exception students, by an increasing degree of flexibility in the length of the course, by an increasing provision of junior colleges in city schools systems, and the like.

3. It does not presuppose an initial vocational choice, but rather offers the student a chance for self discovery and for the estimation of his interests and abilities in relation to broad divisions of human activity. Much of the college-going tendency among American youth appears to have its origin in a desire, largely encouraged by parents and teachers, for a superior vantage point to the home and the secondary school from which to approach a vocational choice. In view of the American tradition that the individual may choose for himself and the economic freedom which permits this choice to be deferred to a comparatively mature age, the sifting and sorting process involved in collegiate education is of fundamental importance.

4. It organizes itself around general fields of knowledge, such as the classics, the languages, the social sciences and the natural sciences, and around the broader divisions of human activity, such as agriculture, commerce, fine arts, home economics, and the like, rather than specific vocations.

5. It places great emphasis on the educational values of in-

stitutional life and organized student activity as a supplement to the formal processes related to the curriculum. The American people have come to regard these as valid educational means in themselves.

6. It is marked by a strong tradition of the independence of the individual institution from external or group control, of the autonomy of departments of organization, of the academic freedom of the individual teacher and of the equal standing of all divisions of knowledge.

*Professional training* appears to have the following characteristics:

1. It aims to develop a special type of person, to fill a place in a group having a special function in society, hence assumes that a definite vocational choice has been made in advance.

2. It models its curriculum and its methods on the technique, functions and special philosophy of the related profession rather than the interests and capacities of individual students.

3. It is generally preceded by a buffer stage of collegiate education, as a means to a discriminating selection of student personnel. Subject matter not having an organic place in the professional discipline is generally relegated to a pre-professional stage.

4. The function of the professional school is specific and well-defined and its methods are correspondingly intensive.

5. Institutional life, as a supplementary educational process or as a valid end in itself, is little emphasized.

6. There is considerable limitation of independence. The individual teacher is expected to subordinate his work to the major aims of the curriculum; departments of organization have limited autonomy; the individual institution yields much of its standard-making function to a group organization of professional schools; and this group organization generally divides this function with representatives of the general body of professional practitioners.

7. Programs of professional training tend to become definitely graded to correspond with the several functional grades

of professional service. For example, in the general realm of the healing art there are distinct programs of training for physicians and dentists, with superposed programs for specialists of various sorts; on other planes are distinctive programs of training for roentgenologists, pharmacists, nurses, optometrists, laboratory technicians, masseurs, dental mechanics and the like; but there is no undifferentiated program of training in which different degrees of survival or success admit to corresponding grades of professional activity.

8. In the training for professions which embody an extended objective technique, such as medicine and dentistry, and to a considerable degree in the training of the professions of social service, the tendency is to include in the scheme of formal training an extended introductory clinical experience under the control of the professional school. With this practice there has grown a tendency to locate the schools with primary regard to the availability of adequate clinical facilities.

It is hoped that these characterizations will be studied critically by engineering educators who are interested in seeing the functions of the engineering schools more clearly defined. Comments and criticisms are urgently invited. They may be sent direct to the author or turned over to the local coöperative committee for transmission. It will be helpful to have the opinions of educators in other fields.

## THE FOUR-YEARS COURSE AND AFTER.

BY J. B. WHITEHEAD, Professor of Electrical Engineering, The Johns Hopkins University.

All engineers who are interested in elevating the status of the profession of engineering, and who believe that this aim can be materially advanced by elevating the standard of engineering education, will be interested in reports that there is a sentiment in the engineering school of Columbia University for the granting of a Bachelor's degree at the end of four collegiate years. It will be recalled that Columbia has recently been exacting two years of collegiate work for admission to engineering courses, and conferring the first degree only after three or four years more. To some, the proposed reversion to the four years' course may appear a retreat from an effort to place education for engineering on a higher plane. It does not so appear to me, if, as we may feel sure, the advanced courses also are to be retained. A strong undergradute school with an emphasis on the importance of advanced training, has a much better chance for advanced students than one which offers no outlet for the larger numbers who do not wish to go on. In fact, the recent Columbia plan appears to have suffered a serious handicap in its requirement of five and six years for the attainment of its first degrees.

There are two (2) sound reasons why it should be possible to obtain the first degree, *i.e.*, a Bachelor's degree of some kind, at the end of four years, whatever may be the field, professional or otherwise, into which the undergraduate wishes to enter. First, there is the tradition and custom of years. Almost every university and college of standing, throughout its life, has been accustomed to hold out to the high school graduate, entering his collegiate period, the reward of some form of Bachelor's degree at the end of four years. The conscious-

ness of this is undoubtedly widely rooted in the minds of those who enter college. The requirement of a longer period is sure to be a discouragement. The second reason is the fact that for perhaps 80 to 90 per cent. of the young men who enter the profession of Engineering, it is possible in a four-year's undergraduate course to give them a sufficient training to enable them to enter the profession, to continue therein under the direction of others, and to perform satisfactorily numerous necessary functions and activities, associated with the applications of Engineering, which do not require for their satisfactory performance any higher type of scientific training.

In other words, our educational institutions are apparently carried away by the magnitude of the problem of supplying these large numbers of young men, who need be trained only partially in the principles of the respective branches of Engineering. It is an unfortunate feature of the field of Engineering, that so many of those engaged in it should have to concern themselves with those practical and concrete operations and problems which are beyond the abilities of young men of general collegiate training, which require a certain technical knowledge or equipment, and yet for which exhaustive scientific training is not essential. It might almost be said that for this vast number of subordinate positions and activities, only a vocational type training should be necessary. Such a statement is in fact true for some of the less important of these positions. One fact, however, that does appear to have been established in the long and wide discussion of proper methods of engineering training, is that the vocational school with absence of fundamental training does not meet sufficiently the requirements of the rank and file of those absorbed into our technical industries each year.

The question then is what to do for the furnishing of the other 10 or 15 per cent., for whom advanced professional scientific training is desirable. First of all it will be granted that only a few universities need offer suitable opportunities, for such training. These opportunities should consist first

of all of a traditional four-year undergraduate course. The content of this course could be varied widely to meet the conditions obtaining in different communities and parts of the country, but it should be standardized at least to the extent of the conferring of the Bachelor's degree at the end of the four-year period. In this way both college and university would be on a common plane as regards the furnishing of the greater mass of the younger men for the industries. The undergraduate course is desirable for those universities which offer training in the graduate field, as feeders to their graduate schools. In these letters, the degrees Master and Doctor should be offered, with the type of training and requirements parallel to those already established by tradition in other fields of study. It is not necessary to introduce at this point a discussion as to the designations of these degrees, but there does appear to be a certain advantage and support in limiting these degrees to "Master" and "Doctor" without the introduction of the degree "Engineer", for which there is no sound historical nor academic basis. Moreover, the dignity of the degree of "Master" would seem to have been appreciably lowered by the custom of many of our schools of engineering, of conferring this degree after one year following the Bachelor's degree. Too often this degree has been conferred as the result of following a few more courses in specialized subjects. Two years of graduate work, paralleling the well established regulations governing the Master of Arts degree in our better known universities, makes the Master's degree in Engineering somewhat more difficult to obtain, but nevertheless adds greatly to its value and if universally required would be one more step toward the elevation of our methods of education for engineering to a plane comparable with that in other professional fields.

In objection to the foregoing someone may recall the venture of Harvard University a few years since, in placing its school of engineering on a strictly graduate basis, and subsequently abandoning the plan, apparently because it did not attract sufficient numbers of students. The answer is that Harvard

did not realize that a graduate school of engineering could not spring into immediate independent being, nor that then even as to-day the first growth of the graduate idea in engineering must be nurtured by the soil of a strong undergraduate school. This is true to-day even in much older fields of study, and Harvard was only too far in advance of the times.

But it is not sufficient that the universities offer the opportunities for graduate study. They can do something in the way of encouraging their four-year's undergraduate to continue into the graduate field. Much can be said of the interest, attractions, and even rewards, resulting from a continuance of their formal training into graduate years. Moreover, the universities have gone even further, in numbers of cases, in the establishing of scholarships and fellowships, offering material assistance to those who will go forward. It is, however, an unfortunate fact that most of the young men who enter engineering schools are in moderate circumstances, in many cases earn their own way, and almost universally look forward to the earliest possible moment in which they can leave the professional school, using such training as they have obtained as a means of livelihood. My own experience shows numerous instances of those who are attracted, and are desirous of continuing into the graduate field, who are prevented from doing so only by the actual necessity of earning their own living, and who are thus unable to resist the attractions held out to them by engineering industries. Advance agents of the latter invaded us this year as early as February and March, presenting glowing pictures of the opportunities of advancement in their respective organizations, and in one case, this year for the first time, actually offered positions and "signed up" some of the graduating class during the visit. This last, a most pernicious practice, is strongly to be condemned and prevented, as diverting attention from the desirability of further training, and as lowering the scholastic and ethical ideals of the young men about to enter the profession.

Is it not evident, therefore, that the present dearth of young men who wish to pursue graduate studies, is due largely to the absence of emphasis by the engineering industries, of the importance of advanced training? There is some evidence that the industries are working within themselves at cross purposes. On the one hand, we have the scouting agents of the industries and their offers which are aimed to pick the flower, and indeed the leaves and whole stem, of our undergraduate classes, and then, on the other hand, we have the hopeful sign created by the establishment of research laboratories in which conderable emphasis is placed on the special scientific qualifications of the men needed to carry on their work. For the present, however, the industrial end of the demand for men would appear to be largely predominating. The research laboratories and other fields requiring men of high training, appear to be taking their chances with Ph.D.'s trained in the pure sciences. As is always the case, these men have measured up in admirable fashion in, and even beyond, their special fields. It must be remembered, however, that it is in the border-land between pure and applied science, that we have the most pressing demand for high ability in the solution of problems, and in contribution to the advance of the whole art of Engineering. It is here that we need men who have devoted their graduate period to Engineering as a principal subject, and who have taken the degree Doctor of Engineering, or have elected Engineering as a principal subject for the degree, Doctor of Philosophy. In other words, industry itself must do more to emphasize the importance of a continuance of formal professional training beyond the undergraduate years. As long as it continues to snatch the whole undergraduate product, and to take its chances in being able to find those capable of handling its more exacting scientific problems, it is probable that the present situation will continue. There are some hopeful signs in the way of research fellowships, and in the way of somewhat better rates of compensation for those who have obtained advanced degrees. It

would appear, however, that a far wider recognition of value of these methods is desirable, and that for a correction of present unfortunate conditions some kind of united action on the part of industry is necessary, in offering encouragement to a certain number of promising young men each year to go forward into advanced work.

# AN EXPERIMENT IN TEACHING FRESHMEN IN ENGINEERING HOW TO STUDY.

BY THOS. P. HARRISON,

Head, Department of English, North Carolina State College.

The number of men entering the freshman classes of technical colleges who fail to go through to graduation is appallingly large. It is practically impossible to get percentage for the entire country; moreover, conditions incident to the War have for eight years disturbed what would have been normal development. Mr. Wickenden, who has made probably the most comprehensive survey of conditions in this matter, states in the May, 1924, number of ENGINEERING EDUCATION, that "taking the country as a whole, it seems probable that not more than forty per cent. of the men admitted to engineering colleges complete the courses and are granted degrees." This opinion is in practical accordance with the experience at North Carolina State College. To cite a specific case: 230 men entered North Carolina State College as freshmen in 1920. Of these men, only 80, or a little less than 35 per cent. were last month graduated.

The Georgia School of Technology under date of June 11, 1924, reports as follows: "Over a period of several years, from thirty to thirty-two per cent. of those who enter the freshman class are lost before the beginning of the sophomore year. Approximately the same number are lost between the beginning of the sophomore year and graduation. In other words, we graduate from thirty-five to forty per cent. of those who enter the freshman class."

The College of Engineering of Cornell University reports under date of June 12, 1924, for five years the graduation of somewhat more than 50 per cent. of those who enter as freshmen. These years, 1913–1917, are, however, war years.

Moreover, deductions from the totals are made for students transferred, presumably to the other Colleges of the University.

The following, dated June 17, 1924, indicates the experience at the Massachusetts Institute of Technology: "We do not have available any exact figures as to percentages of the Freshman Class who graduate. However, we estimate that this is around 40 per cent. The upper classes are swelled by college transfers who form a considerable group beyond the first year."

The loss of six out of every ten who enter technical colleges appears unnecessarily large. It is well, however, to remember that the losses in the literary colleges are perhaps even larger. Rarely does the percentage of graduates in the arts colleges of North Carolina go above 35 of those entering, and in some classes I have examined, only 20 per cent. of a freshman class go through to graduation. The fact that the student in the technical college is working directly toward his profession is strong inducement to him to get the degree if he can possibly do so.

But what are the causes of the loss of this sixty per cent? The causes leading to the withdrawal are, almost without exception, the following:

1. Financial straits,
2. Other family troubles,
3. Ill health of the student,
4. Mistake in selecting course,
5. Failure in work.

Of these causes, the first four account for very few withdrawals, on an average probably fewer than five per cent. Failure in work is the cause of virtually all withdrawals, voluntary or involuntary.

Analysis carried one step further seems to indicate failures in work due to two main causes:

1. Inadequate preparation.
2. Ignorance of how to study effectively.

The relative importance of these factors had never been determined prior to this past year at North Carolina State. I made an attempt during the first semester of the year to get at least an approximate idea of the facts and the remedy to be applied.

My special Department is English, but my work as Dean of the College for thirteen years had brought the problem very acutely to my attention.

My method in making my experiment was not ideal, but the results are interesting. The entire freshman class of 344 men in 12 divisions, averaging, therefore, 29 men in each division, were scheduled to come to me once a week during the first semester of fourteen weeks. A very simple textbook, Kitson's "How to Use Your Mind," was studied intensively. After question-and-answer discussions, each member of the class made a written analytical outline of each of the fifteen chapters of the book. Individual conferences were held with those students who seemed to need special help and suggestions. This work served, therefore, not only to furnish principles to be applied in other studies, but also to be itself a drill in methods of study, of recitation, and of examination.

The most striking reaction of the class appeared to be surprise that there are principles and a distinct procedure, a technique, to be applied in the cultivation of such mental processes as habit, imagination, memory, attention, reasoning, and interest. Their prior idea seemed to be that these powers, like the color of their eyes, came, as Dogberry says of reading and writing, by nature. If a man had them, good; if not, that was his hard luck. There was really nothing to do about the matter in either case.

It is too much to say that these young fellows were interested to the point of putting immediately into practice in all their studies the psychological principles set forth by the author of their textbook; this ideal result is rarely attained even with the exceptional student. My most sanguine hope was to bring the young men to see that there are laws of study, which, if obeyed, will bring definite results; that the principle of cause

and effect is operative in the mind as in mechanics. My main effort was to *awaken* and to *energize* their critical faculty with regard to their methods of study. Not unimportant to the average student, as it seemed to me, is to make him realize that certain physical conditions, as habits of eating and exercise, and his environment of comfort are among the essentials of successful intellectual effort. To accomplish these things early in the student's college life would be to give him a better chance of ultimate success.

Comparative statistics are difficult to present in such manner as to give an absolutely correct impression and in this case the difficulty is increased by a change at North Carolina State College in the method of determining failure. The facts, however, are fairly clear.

During the first semester, before the final examination, 41 of the 344 freshmen were dropped, almost without exception for failure in work. These men were not prepared for college work, either because of lack of training or lack of mentality, and would have been eliminated by stricter application of entrance requirements. On completing the work of the first semester, after the examination, only seven freshmen were reported to the Faculty Committee for dismissal as having made less than 50 per cent. of their credit hours.

During the second semester, ten freshmen were dropped before examination. Of these ten, four failed in the Class in How to Study, four barely passed the subject, one left for financial reasons, the other without stating reason for withdrawing. At the end of the college year, after the examinations of the second semester, only two freshmen were reported to the Faculty Committee for dismissal as having made below 50 per cent. of their credit hours for the entire year, and only eight as not making 75 per cent. of their credit hours for the year and therefore as not entitled to register in September with the sophomore class.

The conclusions to be drawn from this experiment are obvious. The first necessary deduction is that, in fairness to the boys, to their parents, and to the College, entrance re-

quirements should be so applied as to prevent the admission into college of young men lacking mental capacity to do the work, and also to prevent the admission of those having ability, possibly, but without adequate preparation. The second deduction is that systematic instruction of freshmen in methods of study appears to be amply justified. This last is the contribution I have to offer toward the solution of the problem of reducing the high mortality among freshmen admitted to engineering colleges.

The patent objection to giving even one hour a week during one term to systematic instruction in methods of study is that the method of study differs with the subject, and should be taught incidentally with the subject. My little experiment, without argument, would appear to be the sufficient answer to this objection. The only apologium I have to make is that my success, on the surface, seems rather too complete.

# NEW METHODS IN THE EDUCATION OF APPRENTICES AND MECHANICS IN GERMANY.

BY WILLIAM F. TURNBULL,

Instructor in Mechanical Engineering, New York University.

A recent visit to the national headquarters of the Verein Deutscher Ingenieure in Berlin disclosed an interesting development in industrial education which has taken place during and since the war. Previous to the war the educational and industrial delegates to numerous conferences filled volumes with glittering generalities much as they have done in other countries. But under the stress of circumstances and necessity of developing resources to the fullest extent, they have gotten "down to brass tacks" and evolved several invaluable aids to the instruction of shop apprentices and skilled mechanics.

Under the auspices of the V. D. I., which corresponds to our F. A. E. S., a joint committee of delegates from the engineering society and the shops and drafting rooms of the principal industrial plants of Germany met together and devised a comprehensive system of instruction for apprentices and also for skilled workmen.

This consists not of printed lectures or instruction in a didactic form, but of problems and drawings, carefully selected for their instructional value. The courses are based on the unit plan, the unit being a group of problems covering one specialty of a trade, such as metal stamping engine patterns, light forging, ship plate drilling, etc., so that the student will be more definitely interested and the employer will feel more keenly the advantage to himself of the instruction.

The problems or drawings were selected from the contributions of all the delegates, each contributing those which seemed to him typical and possessed of greatest instructional value. The problems are printed on parchment paper and sold in

bound groups to the firm conducting the instruction in its shops. A blank is left in the title so that the firm name can be inserted and the whole blueprinted. The blueprints are then sold in sets to the apprentice who connects the problem with his own firm. In this way a total of one thousand problems covering about twenty-five specialties has been created and checked by the experts in each specialty.

The problems for the apprentices cover drafting symbols and methods, dimensions, limits, economical methods of construction, computation of sizes, shrinkage, gears, location of fastenings, elementary design of molds, tools and dies, as well as screw thread problems. On the other hand the problems for the skilled workmen cover more the technique of operations, order of operations and the usual mistakes and faults found in the shop. The term "normal mistake" has been coined and the experience of all the shops as to normal mistakes has been collated and worked up in a series of wall charts showing side by side the wrong and right method with the reasons therefore. These charts are sold to the firms to be hung on the workshop walls as well as for classes. These provide material for discussion groups among the workmen and result in the evolution of still better technique. The idea that German methods must be made the best and cheapest pervades all and results in many suggestions from the workmen to the planning departments, instead of the planning being done entirely in the office.

The whole outfit is supplemented by sets of instructional lantern slides which are sold or rented by the V. D. I.

# THAYER SCHOOL OF CIVIL ENGINEERING.

BY CHARLES A. HOLDEN,
Director.

In order to understand the Thayer School policy it is necessary to consider the biography of General Sylvanus Thayer, who founded the Thayer School in 1867, although the School was not in active operation until 1871.

General Thayer was graduated from Dartmouth College in 1807, and from the U. S. Military Academy in 1808. After having served in the Corps of Engineers he was sent to Europe to study engineering works and engineering education. Upon his return to this country General Thayer was made Superintendent of West Point which he reorganized, so that he has been called the "father of West Point." As the result of his training, his practical experience, and his study of engineering education, he founded the Thayer School to furnish the training which he considered Engineers should have before entering upon their profession. At that time there were but two branches of engineering, Civil and Military. He, therefore, called the course one in Civil Engineering, although the training is so broad that it includes subjects sometimes listed under other than Civil Engineering, and as a consequence, the graduates are engaged in a wide variety of occupations.

Due to the vision and wisdom of General Thayer in founding the Thayer School and of Professor Fletcher, the Director of the School from 1871 through 1917 (he is now an Overseer of the School), it has not been necessary at any time to reconstruct the Thayer School course and make radical changes but simply to develop it. The Board of Overseers also has contributed largely to the success of the Thayer School. It has had in its personnel, in addition to the President of the

College, at least one member who is an instructor at West Point, one engineer, and, since 1900, one business man. This has given a wide outlook in regard to the School. The Thayer School Alumni have assisted greatly in financial and other ways.

When the writer assumed the directorship in 1918, after having been connected with the School since 1900, it was necessary to formulate for myself a definition of what engineering is in order to plan adequately for the future development of the School. A short, inclusive and exclusive statement is of course not possible. It seems, however, that a satisfactory definition is the one given under the painting in the Associated Libraries room of the Engineers' Building, 33 West 39th Street, New York City,—" Engineering, the (science and) art of organizing and directing men, and of controlling the forces and materials of nature for the benefit of the human race." This conception of engineering made it desirable not to lessen, but rather to enrich, the study of fundamentals, which have to do with " controlling the forces and materials of nature." The work is set for the best students so that no one, however bright and industrious, can say that he has not indicated to him enough work to utilize his best endeavors. At the same time it was evident that more thought should be given to " organizing and directing men . . . and for the benefit of the human race." As interpreted the object of all education is to assist in developing and perfecting civilization, and in furnishing the students with an adequate philosophy of life.

Besides enriching some of the courses, which are commonly listed as Technical, the following developments have been made:

A coöperative arrangement has been made with the Tuck School of Administration and Finance by which Thayer School students take courses in the Tuck School in business organization and management, market organization and management, and financing and accounting. This is in addition to the Thayer School course in contracts and specifications.

Much may be learned by a study of the lives of those engineers who have been leaders in their profession. Therefore each Tuesday morning one member of the School presents to the others a biographical statement in regard to the life of some engineer. This, we hope, will inculcate in the men the desirability of historical research, will show them somewhat of the development of engineering, will illustrate the large accomplishments, through hard work and study, by men without special technical training, and will impress the students of today with the added responsibilities and opportunities which they have by reason of the special training which they are privileged to receive. This also trains students in the public presentation of ideas. Practice in such presentation is obtained also through the use of the reflectoscope in reporting to the other members of the class upon collateral data on the subject matter of the courses in hand.

In order to assist in obtaining a broad appreciation of the possibilities of their profession and of sources of information, and to acquire the habit of wide investigation, about forty selected books are given to the students (one per week in the second year and one every two weeks in the first year). Since the ordinarily understood technical courses must not be slighted there is no opportunity to have formal exercises in regard to this reading. The men are told of the desirability and importance of becoming acquainted with the subjects suggested by these books and they then read in them as much as their time will allow or their inclination compel. At any rate they have handled the books, know there are such subjects, and as a matter of fact do a good deal of reading along these lines. About twenty-six lectures will be given during the year by outside lecturers and seven motion pictures of pertinent subjects will be shown.

The students are warned that the period directly after graduation when they are quite likely to have subordinate positions and before enlarged responsibilities are assumed, is a critical period during which they are liable to suspend study. They are urged not to do this. Also a list of readings

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from good literature, issued by the English Department, will be sent to them to keep them broadened on this side of their lives.

The Thayer School Annual is published each year and gives the addresses and occupations of the alumni at the date of publication in addition to other information. The Annual has been very effective in maintaining the solidarity of the Thayer School Alumni.

The Thayer School course during the first twenty-two years included six years, four years in College and two years in the Thayer School. When Dr. Tucker became President of Dartmouth College in 1893, rearrangements were made so that those men in the College who maintain a high scholastic standing are allowed to take the first year in the Thayer School for the Senior year in College, the entire work conducted in the Thayer School as postgraduate work. The first year extends from the middle of July until the last of April. Those men who return for the second year on the last of September have thus about five months engineering practice before their return. This unique arrangement with the College offers many advantages. The students have three years in College with its broadening and cultural effect. We have the record of the men during the three years in College, so that we can select them according to their accomplishments. Those men who have started an engineering course and find that they are not adapted to mathematical subjects, or who have not the interest and incentive to carry on the work, may not be allowed to enter the Thayer School and thus the drag of such men is eliminated. They are relieved from completing uncongenial work and the engineering profession is relieved from some not adapted to it. These men have the apportunity of continuing in College and they can thus finish a course which is more congenial to them. Those students who do not know that they wish to take the engineering course but find that they are increasingly interested in the mathematical and scientific subjects can change and take the engineering course. Further after having taken the first year in

the Thayer School, at which time they receive the Bachelor's degree from the College, and supplemented this year by five months of engineering practice, men yet have the opportunity of returning for the fifth year or not as they find desirable. After they return and complete the course they receive the degree of Civil Engineer. They have in the meantime secured an excellent training so that they may develop into administrators, or, as is increasingly being done by engineers, they may render service to the nation, state, and municipality. Emphasis throughout the Thayer School course is laid upon teaching the men to think.

Students in the Thayer School have but two recitations per day although they may on the same day have laboratory work. The first year class has, as a rule, about two hours office or laboratory work per day throughout the year. Exercises, therefore, are listed as half days.

The policy of the Thayer School is to give the students a broad training in the fundamentals of engineering, as outlined above, so that they may be adaptable and profit " when improved economic conditions arouse ambition or a new vision makes a change of occupation desirable." The effort is made also to show them their obligation to render civic service and to impress upon them the fact that they are peculiarly well trained for such service.

The management of the Thayer School has always considered that there can never be too many well equipped and trained engineers and therefore has made effort for quality rather than quantity.

# SELECTIVE SECTIONING IN THERMODYNAMICS. A PROGRESS REPORT ON A CONTINUING PEDAGOGICAL EXPERIMENT.

GEORGE W. MUNRO,

*Professor of Thermodynamics, Purdue University, LaFayette, Indiana.*

In June 1924, Purdue University completed the third semester of an experiment in selective sectioning of students in thermodynamics. During this time so much has been learned that it seems worth while to set forth in some detail the object sought, the methods employed, the difficulties encountered and the results secured, for guidance in future work along this line.

## The Objects of Honor Sections.

In sectioning students on the basis of ability the main objectives are:

A better rate of progress, made possible by relieving the very good student from the drag of the very poor student.

A higher plane of class discussion, through the elimination of the many puerile questions which consume so much time and so bore the more capable students.

Better adjustment of class drill work to the needs of each kind of student.

To these may be added the gain that should come because the poor student placed in direct competition with those of his own class or ability, is less conscious of his shortcomings, less apt to become discouraged, feels more free to ask questions and is generally more able to participate in the class discussions which seldom get beyond his comprehension. Also the students of ability who are tempted to specialize in "activities" are spurred by pride to maintain standing in the higher sections.

## SELECTIVE SECTIONING IN THERMODYNAMICS.

### Basis of Sectioning.

In considering the basis of sectioning certain principles were outlined and kept in mind.

1. The best students have earned and are entitled to the best instruction.

2. Membership in the honor section must be entirely optional with the students who can qualify.

3. Students are ambitious and naturally desire to gain scholastic distinction.

4. Membership in honor sections must offer real attractions: these sections must eventually prove popular.

5. Additional work of itself is no attraction: a higher class of work *is*.

6. Transfer between honor and regular sections at any time must be practical.

7. The system of selection must appeal to the students as fair and must not appear to close the door of opportunity.

8. The system must have the hearty cooperation of all the instructors, especially of those who must handle the less advanced regular sections.

### Method of Sectioning.

The condition of ready transfer from section to section requires scheduling two classes under different instructors at the same hour. This has proved feasible, so one of the absolutely necessary conditions for the success of the system has been met.

The method of selection was determined after conference with a representative group of the class. Briefly it was that the work should be conducted in the usual way until after the third regular test. Students with grades above 85 were then to be eligible for the honor sections. In practice this limit was lowered a point or two in a few cases to include some men of exceptional promise. The division resulted in 42 eligibles and 57 who were not allowed a choice of sections.

The passing grades at Purdue are: A, passed with honor (90–100); B, passed with credit (80–90); P, passed (70–80).

At the beginning announcement was made that "A," the honor grade, would only be given in the honor sections and that when a student fell below the "B" level he would be transferred to the regular section forthwith: that is, that the final grades given in the honor sections would be A and B and in the regular sections B and below. Restricting honor grades to the honor sections added the incentive of scholastic distinction.

When the appointed time for division came the eligibles all were given the choice of remaining with the honor sections or continuing the regular work with the instructor meeting the other section at the same hour. Two of the eligibles elected to remain regular, the others going on with the honor sections. Subsequently, during the first semester, one honor man elected to transfer to a regular section, two transferred by request and one man was advanced to the honor section because of exceptional showing in the regular work. This amount of transfer seemed to show that the machinery was functioning correctly.

### Final Grades.

At the end of the semester 98 men received final grades, 39 of these finishing with the honor sections under one instructor and 59 with the regular sections under four other instructors.

TABLE I.

Grade Distribution, June, 1923.

| Sections. | Grades. | | | | | I, Incomplete on Account of Sickness. | Total. |
|---|---|---|---|---|---|---|---|
| | A, 90–100. | B, 80–90. | P, 70–80. | C, 50–70. | D, 0–50. | | |
| Honor Sections... | 23 | 12 | 4 | — | — | — | 39 |
| Regular Sections.. | — | 16 | 31 | 6 | 4 | 2 | 59 |
| Total..... | 23 | 28 | 35 | 6 | 4 | 2 | 98 |

This total grade distribution may be considered entirely normal for this subject at Purdue and so it fulfills a pre-

liminary statement made to the students that the new system was in no wise intended to effect a change of standards in the subject. The four students receiving P in the honor sections acquired deficiencies too late to make transfer to regular sections practical.

### Continuation of the Work in the Second Semester.

When the work was resumed in September an eligible list was prepared on the basis of an 85 per cent. grade for the work of the first semester. Of the 34 men so eligible 30 were previously in the honor sections and four in the regular sections. Two men did not return, one secured credit on the basis of summer school work at a neighboring university and one elected to remain in a regular section for personal reasons. To the remaining 30 who elected the honor section work were added one graduate student and two A grade students not in the university the previous year. The enrollment of 93 in the subject at mid-semester is thus divided into 60 students in regular sections under two instructors and 33 in honor sections under one other instructor.

At mid-semester an opportunity was given to those in the regular sections having grades above 85 per cent. to transfer to the honor sections. Three men did so but several eligible for this transfer preferred to remain in the regular sections where they had been able to do very satisfactory work, rather than to transfer to the other sections with new and untried conditions. This was with the distinct understanding that honor grades would only be given to students in the honor sections. No transfers were made to regular sections at this time.

### Final Grades, Second Semester.

At the close of the second semester, which completed the year of required work in Thermodynamics, the grades were distributed as in Table II.

TABLE II.

GRADE DISTRIBUTION, FEBRUARY, 1924.

| Sections. | Grades. | | | | | I, Incomplete on Account of Sickness. | Total. |
|---|---|---|---|---|---|---|---|
| | A, 90–100. | B, 80–90. | P, 70–80. | C, 50–70. | D, 0–50. | | |
| Honor Section.... | 23 | 11 | — | — | — | 1 | 35 |
| Regular Sections.. | 5 | 32 | 18 | 1 | — | — | 56 |
| Total..... | 28 | 43 | 18 | 1 | | 1 | 91 |

Five men in the regular sections were given honor grades of A. This was not a change of policy but was done in each case on recommendation of the instructor, considered in conference by the Dean of Engineering, the Head of the School of Mechanical Engineering and myself. In each case it was recognition of work well done under handicaps rather than because a class standing happened to cross a critical line of ninety per cent. Each year there are a few men who find themselves and come out from behind and in doing this there is frequently shown a sort of dauntless courage that should be individually recognized and rewarded. Provision for this recognition of the rising individual is difficult to systematize, yet in all fairness it must be made. In this work each case was considered by itself and on its merits.

At the end of the first year attempt was made to analyze the results attained to determine whether the work should be continued along the same or similar lines with the new class about to begin the subject. This analysis was made under three heads as follows:

(1) Is the method workable?

(2) Are the results worth while?

(3) The cost.

In answer to the first it could be stated that the system was working with unexpected smoothness; that the better students had been separated from the poorer students without ill-feeling or friction and that the eligibles were taking the advanced work, practically without exception. Moreover, there

seemed to be a healthy rivalry for membership in the honor group and all the instructors agreed that the administration of the work in all groups was improved by the separation of the superior from the inferior students.

In considering whether or not the results, present or prospective, were worth while, from the nature of the case less positive indications could be expected. It early appeared that some of the anticipated results of selective sectioning could not be realized. While the best students are incomparably better than the poorest, a division of the class near the median line does not permit of work of a greatly advanced nature in the higher section. It must also be appreciated that with students carrying six or more lines of study it is impossible to secure work corresponding in nature to graduate work, even from the best men. To give such careful thought to a question as to even approach the quality of research requires greater concentration of mental effort than the diversified activities of the undergraduate plan of study permits.

Keeping open the channel of ready transfer between sections requires that the ground covered by the sections be the same and, perhaps, with the credit remaining the same, it is only fair, and so best, that the required work should remain the same for the two groups.

This arrangement provides a segregated group of superior students who can do quickly, easily and well the work that is covered at the expense of much time and labor by those in the other group and then with only indifferent results. This leaves available with these men some time,—time which this class of students have always had but which under previous conditions was not at the same time available to the instructor.

The profitable utilization of this time is the problem of the instructor of the honor sections. In approaching this problem it should be remembered that this group contains:

1. The men of the intellectual type.
2. The men with a catholicity of interest who will desire an education of the cultural type.

3. The men to whom educational processes are pleasant and easy.
4. The men likely to possess the larger vision.
5. The men who will become teachers, especially college teachers.
6. The men who will become research workers.
7. The men who will pursue for themselves any line in which they may become interested.

In short, this upper third of the class contains the great bulk of the active possibilities for intellectual and social leadership.

Having available a number of scheduled hours which the members of the class do not need for drill work, the profitable utilization of this time becomes the problem of the teacher. With this particular class the attempt was made to interest them in the fundamental physics by reading to them outstanding addresses by Sir Earnest Rutherford, Robert A. Millikan and others with such interpretations as the instructor could make. This called the attention of these men to such fascinating fields of inquiry as atomic structure, quantum theory and relativity. Timely addresses at the university by Prof. Wm. D. Harkness and Mr. John Mills served to illuminate the work in the class. It is believed that on the whole the time was profitably spent.

However, there is in such an arrangement the fundamental objection that time assigned to one subject is made available for some other subject and that chosen at the pleasure of the instructor in charge of the class. In the present instance, the instructor kept to subjects which are readily recognized as basic to thermodynamics, but there was nothing to prevent his personally conducting an excursion through politics, philosophy or religion, had his immediate interests extended into some of those fields. In short, the value of the system depended on the individual characteristics and capacities of the instructor rather than the arrangement of schedule and hours. Attempt is now being made to remedy this deficiency in the system by reducing the schedule hours and allowing each

student to utilize the extra time as best pleases him. With this advanced group of students this seems a safe procedure for as a rule they are using and not wasting their time at college.

## Costs.

In considering the question of costs, it should be recognized that the upper third of the members of our classes have in the past received very little of our instructional effort, and so have passed through the University without materially adding to our instructional costs. In general they ask few questions, require little assistance, and their problems and quiz papers being usually correct take little of any instructor's energy. On the other hand, they do much positive teaching to other men in their sections. Separated, they appear in small sections and most be supplied with the best and presumably the highest priced instruction available. This accords with the principle that the best students have earned and are entitled to the best instruction, but departs sharply from general practice.

It is entirely beside the mark to say that as no additional instructors have been employed, the work so far has not added to costs of instruction. Added costs may be concealed for a time, but when there is an increase of teaching burden some one must carry it and eventually it must be paid for. In any analysis, costs must be fairly stated and balanced against benefits, present or prospective. Selective sectioning will eventually show in added costs at the business office.

After careful consideration of the results of the first year it was decided to continue the selective sectioning of students in thermodynamics for at least another year on essentially the same basis as before.

## Beginning the Second Year.

Profiting by the experience of the first year, some changes were made in the system of conducting the advanced sections, though the same general scheme of division was followed.

Chief of these changes was the reduction of the class schedule for the honor students from three to two meetings a week. This was for a twofold purpose.

1. It was thought that the free hour in the schedule would be greatly desired by the students and would serve as an objective toward which they would strive, becoming a direct stimulus to high grade class work.

2. It would make "spoon feeding" physically impossible, thus insuring that in the honor sections there would be real studious effort outside the class room and a real difference in grade values of the same numerical standing. This would justify the restriction of A, the honor grade, to the honor sections; a proceeding hitherto on an arbitrary rather than a logical basis.

A third object also gained by this arrangement was the securing of an available schedule hour to both instructor and students in which could be established a special double pace class as explained later.

During this semester 135 students were enrolled in this subject under three instructors. Of these 69 were eligible for membership in the honor sections as having an average of 85 per cent. or above on the first three tests. Twenty of the 69 elected to remain in the regular sections and recite three times a week, leaving 49 enrolled in the honor sections on the reduced schedule. Subsequently seven of these men elected to make the transfer, together with two others not eligible at the first division. This left 13 students who deliberately chose membership in the lower section against three at the same time in the previous year.

Perhaps it is idle to speculate regarding the motives which impelled twenty men to remain in the regular sections. However, the impressions gained by the instructors in talking with the students and in handling the work have a certain value in forming judgment as to why this was so.

1. The fear that the reduction of class hours would result disastrously to a somewhat precarious grade seems the principal reason for letting very well alone. That this was a

justified attitude is shown by the fact that half of the twenty had lower standing on May 1, than on March 20, nine actually having lost eligibility by dropping below 85 per cent. by that time.

2. The liking for an instructor and a feeling of loyalty to him has undoubtedly influenced the actions of a number of students in their choice of sections.

3. In at least one instance the fact that A grades had been given to members of the regular sections in the previous semester led to the belief that it would be the general practice. Of course this led to disappointment.

### Final Grades, Third Semester.

At the close of the semester the grade distribution between sections was as shown in Table III.

TABLE III.

Grade Distribution, June, 1924.

| Sections. | Grades. | | | | | I, Incomplete on Account of Sickness. | Total. |
|---|---|---|---|---|---|---|---|
| | A, 90–100. | B, 80–90. | P, 70–80. | C, 50–70. | D, 0–50. | | |
| Honor | 30 | 25 | 3 | — | — | — | 58 |
| Regular | — | 24 | 47 | 4 | 1 | — | 76 |
| Total | 30 | 49 | 50 | 4 | 1 | | 134 |

The reduction in the proportion of A grades over that of the year previous shown in Table I is notable. Three factors probably contributed to this result. (1) The class may have had somewhat fewer exceptional men. (2) The final semester examinations had a tendency to reduce standings. Finals were introduced at Purdue this year for the first time, and both instructors and students were equally inexperienced in final examination technique. (3) The reduction in class hours and consequent changes in class method undoubtedly had some effect on the grades.

### Plans for Continuation.

The eligible list for the honor sections as now made up contains 48 names of men with semester averages of 85 per cent. or above. Of these, six were in regular sections last semester. This list is decreased by nine men who have already completed the work of the next semester and have finished the subject, as outlined later. This leaves 39 men eligible for membership in the honor sections next semester and 91 for the regular sections. As each group must be handled in three scheduled sections and allowing for shrinkage over summer vacations, the probable average section size will be about 12 and 28 which illustrates the principle difficulty of selective section. *There are too few good men* and *too many poor ones.* The burden of teaching can not be equalized, even in a large school.

### A High Speed Section.

It has long been the opinion of the writer that the regular pace of college classes is as much too slow for some students as it is too rapid for others: that schedule difficulties aside, a considerable number of our students could complete the required course of study in materially less than the conventional four years.

With the decision to reduce the schedule hours in thermodynamics from three to two I announced that opportunity would be given to a select few, not over six, exceptionally prepared men to complete the two semesters work in the subject in the single semester, utilizing for the purpose the hour vacated by the reduction of schedule. More than thirty applications were received for permission to double on the work in this way, twelve finally being accepted for membership in this group strictly on a basis of their previous scholastic record. This was twice as many as originally intended but there seemed little to choose in the records of these men. However, three dropped out soon, only one, however, for scholastic reasons, leaving nine who carried the double work, all successfully.

In carrying on this special class certain difficulties not properly associated with a double paced class were encountered, The division of the regular class was not until after seven weeks during which time there were no scheduled hours for meeting but special conference hours were arranged for each student. Again, much of the work of the second semester depends on basic principles developed during the first semester. This made it necessary to rapidly cover a considerable portion of the work of the first semester in advance of the regular section before the work of the second semester could properly be begun. Lack of meeting hours prevented the giving of the usual written tests in order so that the students came to the final comprehensive examination with almost no class drill and only two preliminary tests. Notwithstanding all these handicaps eight of the nine men made A grades on examinations as comprehensive and searching as were given to the regular students on the semester finals the previous semester. The single student who made less than A on this test (he made P) was carrying a large amount of other extra work, nearly double the regular schedule, in preparation for dropping out one semester and yet graduating with his class. Considering the success of these men in carrying this additional work under handicaps, I am of the opinion that the properly arranged double pace class offers a real solution to a number of our educational problems associated with the exceptional or gifted men. In many ways it would be simpler to organize and maintain, cheaper in instructional costs and would offer greater incentive to the student than the present system of selective sectioning. As it might be offered as a special privilege to a few with exceptional scholastic records, a much closer selection could be made than can now in fairness be obtained. It is recommended for earnest consideration.

# FIVE-YEAR COURSES AT THE UNIVERSITY OF ALABAMA.

BY GEO. JACOB DAVIS, JR.,
Dean, College of Engineering.

The University of Alabama offers ten systematic four-year courses leading to the following degrees: Bachelor of Science in Chemical Engineering; Bachelor of Science in Civil Engineering; Bachelor of Science in Commercial Engineering; Bachelor of Science in Electrical Engineering; Bachelor of Science in Hydraulic Engineering; Bachelor of Science in Industrial Management; Bachelor of Science in Mechanical Engineering; Bachelor of Science in Metallurgical Engineering; Bachelor of Science in Mining Engineering; Bachelor of Science in Sanitary Enginering.

In general our engineering students are preparing for active technical and administrative work in the great industries of the Birmingham and other manufacturing districts of Alabama. The majority of them do not care for a broader education than is offered in the above four-year courses. Furthermore, there is a feeling on the part of our engineering faculty that the average engineering student will profit more by a year's contact with industry than by an additional year devoted to specialization in college.

There are, however, exceptional students. The occasional student desires a broader education than the above four-year courses supply. Some students are adapted for teaching and can profit by more extended courses. Others are destined to be research men and accordingly need specialized courses of study along their chosen lines.

For such classes of men five-year courses have been outlined. These courses lead to the degree of bachelor of science (without designation of the course taken) at the end of the fourth year and, in addition, to the degree of bachelor of

science in engineering (with designation of the course taken) at the end of the fifth year. All of the subjects of the regular four-year technical courses are included in the five-year curricula, with additional required work in English, foreign language, history and economics and opportunity for the election of additional cultural studies.

While both four-year and five-year courses are being offered the number of students taking the latter will probably continue to be only a small proportion of the total. They will probably continue to be rather exceptional also in their preliminary training and their natural endowments. They will therefore require individual treatment rather than handling in mass.

The five-year curricula which have been prepared are not, therefore, published in the University catalog, but are kept on file merely as guides in planning the individual student's work. In order to receive the degree of bachelor of science after the fourth year of a five-year course, a student must satisfy the following requirements: He must receive credit for 144 semester hours of college work, at least 12 of which shall be for English, 12 hours for foreign language, 12 hours for mathematics, and 12 hours for history and economics. He shall, in addition receive credit for all natural science courses which are specified in the regular four-year curriculum courses.

In order to receive the degree of bachelor of science in engineering (with designation of the course taken) on completion of a five-year course the student must have taken at least thirty semester hours of work in the fifth year and have received credit for all courses required in the regular four-year technical courses.

The regular engineering courses require twenty semester hours of mathematics. The requirement of only twelve semester hours in the first four years of the five-year course is for the accommodation of those students who may decide upon an engineering career after having taken two or three years of work in the college of arts and sciences. Exceptional

students of the type who will take these courses will have developed more mathematical ability in twelve hours of training than will the average student in twenty-hours. That only exceptional men will elect these courses will be apparent when it is considered that a student may receive an A.B. degree in the college of arts and sciences on completion of 128 semester hours of work, whereas 144 semester hours of work are required for the B.S. degree in the first four years of our five-year courses. The college of arts and sciences no longer gives the B.S. degree.

The offering of both four-year and five-year courses, in the way outlined above effectively provides, we believe, for the needs of the different types of students and the demands of the industries.

A tentative outline for a five-year civil engineering course conforming to our requirements is given below:

*First Year*

| | Hours Credit. | |
|---|---|---|
| | 1st Sem. | 2d Sem. |
| Chemistry | 4 | 4 |
| Drawing | 4 | 4 |
| English | 2 | 2 |
| Hygiene | 1 | 1 |
| Mathematics | 5 | 5 |
| Military | 1 | 1 |
| Orientation | 1 | |
| Surveying | | 2 |
| | 18 | 19 |

*Second Year.*

| | Hours Credit. | |
|---|---|---|
| | 1st Sem. | 2d Sem. |
| Drawing | 2 | |
| Foreign language | 3 | 3 |
| Mathematics | 5 | 5 |
| Military | 1 | 1 |
| Physics | 7 | 7 |
| Highway engineering | | 3 |
| | 18 | 19 |

*Third Year.*

| | Hours Credit. 1st Sem. | 2d Sem. |
|---|---|---|
| Foreign language | 3 | 3 |
| Geology | 3 | |
| History | 3 | 3 |
| Hydrology | | 3 |
| Mechanics | 5 | 5 |
| Surveying | 3 | 3 |
| Elective | 2 | 2 |
| | 19 | 19 |

*Fourth Year.*

| | Hours Credit. 1st Sem. | 2d Sem. |
|---|---|---|
| English | 3 | 3 |
| Economics | 3 | 3 |
| Electrical engineering | 4½ | 4½ |
| Steam engineering | 3 | |
| Public speaking | 1 | 1 |
| Railway engineering | 3 | 3 |
| Stresses in structures | | 3 |
| Elective | 2 | 2 |
| | 19½ | 19½ |

*Fifth Year*

| | Hours Credit. 1st Sem. | 2d Sem. |
|---|---|---|
| Masonry, reinforced concrete | 2 | 2 |
| Theory of structures, details | 3 | 3 |
| Engineering jurisprudence | 2 | |
| Engineering economics | | 2 |
| Hydraulics | 2 | |
| Cement laboratory, materials laboratory, | 2 | 2 |
| Steam laboratory | | 2 |
| Thesis | 3 | 3 |
| Elective | 4 | 4 |
| | 18 | 18 |

The two hours elective in the third and fourth years are to provide for advanced military work in the R. O. T. C.

## COLLEGE NOTES.

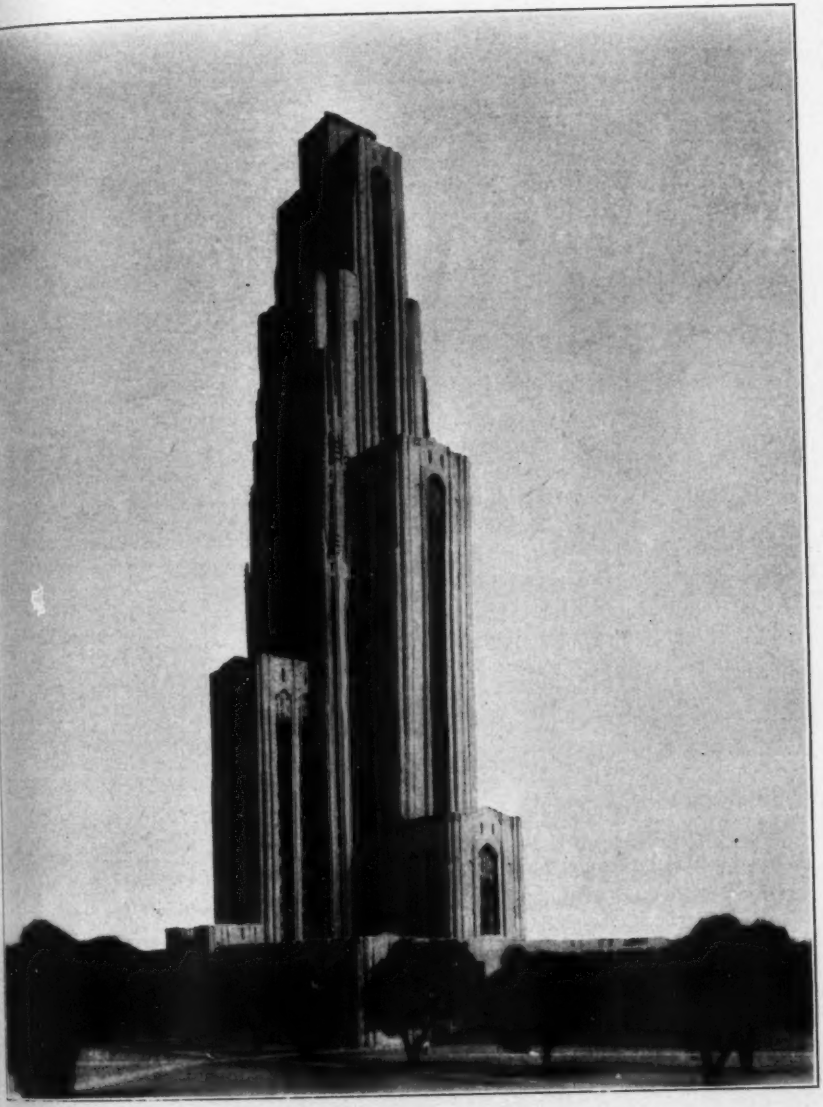
**University of Pittsburgh.** A central building, rising 680 feet, beautiful and inspiring in its proportions, taking its place among the other great buildings of the world, will be erected by the University of Pittsburgh next year at a cost of $10,000,000.

The building is to be a cathedral of learning, a great central symbol, which makes the heart leap up and understand Pittsburgh. It is to tell with unforgettable clearness the inherent hope of the men and women of Pittsburgh. The structure will not be an imitation of anything, but rather an original and adequate expression of local character, local historical memory, and local aspiration.

This stupendous educational project to express Pittsburgh's spirit of achievement has been Chancellor John G. Bowman's vision for several years. The building will be Gothic in style, 360 feet long, 260 feet wide, and 680 feet high, having 52 stories reached by 16 high-speed elevators. The design was executed by Charles Z. Klauder of Philadelphia, considered the leading exponent of Gothic architecture, as applied to college buildings, in this country.

Although comparable with great cathedrals in its beauty, the new building will be essentially an educational institution in appearance. It will be the nucleus of the University, providing classrooms, libraries, shops and laboratories for all the schools except those of medicine and dentistry. The four main doorways will be 39 feet high. The material used will be white Kentucky limestone and the structure will be the tallest and most imposing masonry building in the world.

The new building is to be the greatest structure ever erected by any community to tell its own living will. By its architecture and by its purpose the building is to record in an atmosphere of worship the effort of those who made Pittsburgh what it is. The building is to be high, not for the sake of



being high, but for the power of inspiration and for the sublimity which great height together with the right proportions, mass, lines, and pointed Gothic arches can give.

The building will tell the story of the pioneers by its lift and form, by its purpose, by fine paintings hung here and there on the walls, by friezes decorating the study rooms, memorial laboratories, lecture rooms, and libraries. The building will keep vivid the lives of those who have done good work for Pittsburgh—who have produced music, built up industry, extended our knowledge of truth, or interpreted the use and beauty of life.

Speaking of the single high structure idea for a university, Chancellor Bowman declared that to express courage, daring and achievement, height and perpendicular lines are imperative. Unity of the entire University will also be gained. Splitting of knowledge into artificial bits is largely the result of studying subjects in many separate buildings. One building will aid in the coördination of isolated units into a single system of thinking.

The cost per cubic foot of the high building will be somewhat above the corresponding cost of a low building. This will be largely offset by advantages of better light, better ventilation, less noise, less dust and decreased cost of upkeep.

The foundation of the building will require only about one and three-fourths acres of a 14-acre quadrangle owned by the the University in the Schenley Park district, leaving room for several buildings of the future. The present campus of 65 acres is largely on a hillside, and will be retained for certain professional schools and dormitories.

If four-story buildings were to be erected, the entire tract would be covered. The saving in land by high construction approximates $2,000,000. The elevator service is a more simple engineering problem than that of a corresponding general office building. High construction creates a great flexibility in the use of space. Departments may be expanded or contracted as circumstances require. The building will have no equal anywhere as a memorial expression of a city's spirit.